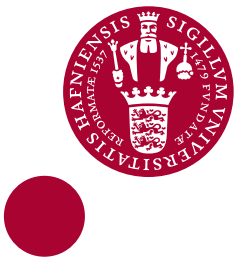

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Plant eco-physiological response patterns to summer drought, elevated CO_2 and warming in a semi-natural temperate heath ecosystem

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Plant eco-physiological responses to multiple environmental changes are being studied in a temperate semi-natural heath ecosystem according to a realistic Danish climatic scenario anno 2075. Since direction of ecosystem responses can not be deduced from single factor experiments alone this necessitates the multi-factor approach. The environmental treatments are elevated level of CO_2 (FACE 510 ppm, [CO2]), passive nighttime warming (IR-reflective curtains, [T]) and summer drought (rain activated curtains, [D]) and started in Oct. 2005. Leaf level carbon input and water consumption through photosynthesis were measured by gas exchange techniques on Common Heather (*Calluna vulgaris*) and Hair Grass (*Deschampsia flexuosa*). Parallel measurements of chlorophyll-flourescence, xylem water potential, leaf carbon and nitrogen content were conducted. In summer 2007, [D] decreased plant available soil water led to significantly lower plant water potential compared to controls, whereas [CO2] and [T] had no effect. The plant water potential was 2-3 times lower in the deep rooted woody shrub *C. vulgaris* compared to the grass *D. flexuosa*. No visual symptoms of drought stress were seen for *C. vulgaris*, but part of *D. flexuosa* had senescent leaves. For both species no effects on maximal carboxylation velocity, V_{cmax}, and maximum rate of electron transport, J_{max}, were seen, but for *D. flexuosa* [D] increased day time respiration, R_d, was found. Despite small impact on photosynthetic parameters V_{cmax} and J_{max} we observed a significantly decreased maximal photosynthesis in [D] for both species. Under field conditions the transpiration rates were significantly lowered by [D], but [CO2] and [T] had no effect. Interactions between [D*CO2] and [T*D*CO2] showed lower transpiration rates than expected whereas [T*CO2] were higher for *C. vulgaris*. Parallel responses were seen for values of stomatal conductance. These responses indicate the strong impact of [D] linking low water availability to decreased plant water potential and water consumption via transpiration. Further, the [D] also decreased the net photosynthesis for both species, while [CO2] had the opposite effect. In combination this led to a significantly higher Water Use Efficiency in [CO2]. The increased carbon uptake increased the leaf C/N ratio through a marginal, but significant, C% decrease and a stronger N% decrease in [CO2]. These issues of the contrasting response patterns could not be deduced from single factor studies alone and adds to the importance of long term multifactor studies.